Paint and Varnish PRODUCTION MANAGER

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PRACTICAL OBSERVATIONS ON THE PRODUCTION OF ACID-PROOF PAINTS AND VARNISHES

DR. AUGUST KUFFERATH

It is a well known fact that many of the so-called "acid-proof" paints and varnishes fail as soon as they are exposed to continuous actions of mineral acids or vapors under certain, more or less unfavorable, operating conditions. For instance, some of these paints and varnishes, or rather the films produced with them, may successfully withstand the action of atmospheres contaminated with hydrochloric acid vapors for a long time, only to collapse within a few weeks under conditions apparently much less corrosive. The same applies in a still more radical way to nitrous acid vapors.

There can be no doubt that in many instances this is due to some mechanical changes such as occasional damages of the films by friction, scratching, blows, etc., but also by bending, sudden abrupt changes of temperature, prolonged vibrations, while in some instances occasional abrupt increases of the degree of humidity, blasts of vapor, etc., proved to be the real intrinsic reasons for the collapse of the acid-proof paints or varnishes.

Another group of reasons comes under the head of application. Incorrect methods of cleaning the surfaces previous to application, subjection of the cleaned or uncleaned surfaces to the action of the acid vapors previous to paint or varnishing, contamination of the paints within the open pails etc., and chief of all, incorrect application. Deep brush marks are bound to reduce the life of such films the same as scratches, etc., later on. The edges of the underground materials may be insufficiently covered, and the underrusting caused by the penetration of the corrosive vapors even through comparatively small faults of this type are bound to induce general corrosion of the films, especially if this is supported by unfavorable outside conditions.

Incorrect methods of storage, excessive duration of storage, painting during very moist weather or early in the morning without removing the dew or other moisture from metallic surfaces, exposure to heavy acid fumes during drying of the film, and many other possibilities may arise to lower the resistance of the paint and varnish films.

It is obvious, therefore, that before changing the composition of acid-proof paints and varnishes all these possibilities should be carefully examined. It will be found that there are still lots of ocassions calling for changes of composition of the paint materials themselves, either because of some intrinsic error of composition or in order to adapt the paint or varnish to certain local special conditions.

Regardless of theoretical observations the following general practical rules may therefore be applied:

1) Most high grade paint and varnishes containing suitable pigments exhibit a certain amount of acid-chemical resistance if all factors of production, storage, application and treatment of the films are duly considered.
2) Even high grade, specially produced acid-proof paint and varnish films are really acid-proof only if they are protected against detrimental mechanical influences from the

outside and against sub-rusting (due to faulty application) from within.

3) Most anti-rusting or acid-proof paint and varnish films are just as sensitive against elevated temperatures as ordinary paint films.
4) All acid proof paint and varnish films retain their characteristic properties after prolonged ageing periods only if—apart from the mechanical stresses mentioned above—they are not exposed to continuous vibrations and pronounced bending stresses.
5) Acid vapors dispersed within dry, cool atmospheres react not nearly as sharply as similar or even weaker atmospheres saturated with moisture or heated to relatively high atmospheric temperatures.
6) Strictly gaseous vapors exert a different corrosive influence than similarly composed vapors reacting under conditions favoring the formation of dew on the metallic surfaces.
7) The "acid resistance" of many paints and varnishes are limited to certain specified acids or chemical conditions but may fail under others. In filling orders for such material the exact conditions of exposure must therefore be specified.
8) The priming coat depends to a very large degree on the properties of the top coat, and vice versa. It is useless to consider all characteristic requirements with regard to one of these films alone.
9) The priming coat depends not only on the top coat but on the properties of the base material as well. For instance, trouble is bound to occur if a priming coat of low elasticity is applied to bases of considerable expansion and beneath a top film of entirely different physical properties. Spalling and cracking are greatly conducive to rapid destruction of the "acid-proof" films.

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There are a number of other special requirements but the above represent the basic conditions on which most of the others depend in one or the other way. Acid proof varnishes must therefore possess excellent chemical and physical properties, the latter ones being just as important as the straight acid-proof characteristics themselves. Indeed, there can be no doubt, that for moderate acid corrosion, varnish or lacquer films of ordinary composition but best physical or mechanical properties are often better suited than compositions of perfect chemical features but imperfect physical and mechanical behavior.

We realize, of course, that in offering the above observations we did not disclose any startling revelations. These factors are very evident, indeed, but since they are all equally important to the actual life of the products, and since one or the other factor is often overlooked in compounding and applying the paints and varnishes, it appeared necessary to dwell on them at considerable detail before concentrating on the compositions themselves. It is indeed useless to study this problem merely from the point of view of greater or lesser resistance of the components of acid proof paint materials to the specific reagents without realizing that even the most perfectly composed materials of this type are bound to fail as soon as, due to physical weaknesses, the films develop only one single little opening to the base material, permitting the corrosive reagents to initiate underrusting beneath the films. Only a combination of good vehicles, solvents and pigments is able beyond doubt to fulfil the requirements in question—provided that storage, application and treatment of the films are in line with the conditions involved.

High grade acid resistant paint, varnish and lacquer materials are usually obtained with synthetic resins produced by the condensation of polyvalent alcohols and suitable polibasic acids in presence of selected drying oils or of the fatty acid of such oils. Similarly good results are obtained with lacquers produced from high-grade nitrocellulose mixed with special softeners and phosphoric acid—or suitable phosphates—in amounts of 0.05-1.00% and with suitable acid-proof pigments. In some cases, for instances in order to increase the resistance to moist atmospheres containing hydrochloric acid vapors, it is often found advisable to incorporate small amounts (for instance, 10%) of a high grade natural resin.

Serious difficulties encountered in Germany during the war were induced by the lack of drying oils, such as linseed oil or wood oil, and the corresponding stand oils which proved particularly troublesome in the production of acid-proof varnishes and lacquers resistant to organic acid, fruit acids, etc., in the food industries. Tin plate was

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not available for the production of food preserves and lacquered black plate was therefore used exclusively. Within a comparatively short time, however, this difficulty was overcome. It was possible not only to obtain pronounced improvements of the products based on nitro-, acetyl- and benzyl cellulose but also of the phenol-formaldehyde condensates as well as of the products based on phtalic acid, polyvinyl chloride and urea-formaldehyde condensates.

Of considerable value in this respect proved to be the high degree of solubility or dilutability of the phenol- or cresol-formaldehyde condensates with esthers, ketones, etc., such as methyl acetate, ethyl acetate, propyl- or butyl acetates, aceton, anon, etc., also with glycol ethers and their acetates. Cutting agents used in this connection are alcohols such as methyl-, ethyl-, propyl- and isobutyl alcohols, as well as aromatic hydrocarbons, hydrocarbon chlorides, oil of turpentine.

A highly resistant white lacquer is composed as follows:

Nitrocellulose	5 %	
Phenol resin	25 %	
Dibutyl phtalate	1 %	
Titanium dioxide	13 %	(absolutely acid-proof)
Phosphoric acid	0.3%	
Solvents	29 %	
Thinners	26.7%	

For many purposes, chiefly for scientific apparatus in chemical laboratories, etc., special lacquers such as the so-called crackle lacquers, are frequently required which in spite of their comparatively unfavorable physical condition must exhibit a high degree of resistance against the various corrosive influences characterizing such atmospheres. It has been found impossible to produce chemically resistant mixtures of this type without at least a certain proportion of drying fatty oils or their fatty acids. A very resistant lacquer of this type is produced as follows:

A modified phenol aldehyde resin or, better, an alkyde resin modified with natural resins is heated for 20 minutes at a temperature of 485 degrees Fahrenheit with glycerin or a modern glycerin substitute, a current of carbonic acid gas being conducted through the mixture of reaction. The product is mixed with wood oil and linseed fatty acids until a clear solution is obtained, the mixture being maintained at 485 degrees Fahrenheit until this point is reached. The temperature is then lowered to 455 degrees Fahrenheit. Phtalic acid or another suitable polybasic acid is then added and esterified in a current of carbonic acid until a resin of the acid number 10 is obtained. This product is maintained at a temperature of 350 degrees Fahrenheit and treated with a current of air, usually in presence of a catalytic substance such as caustic soda, sodium carbonate, cobalt- or lead acetate. The product is thinned with toluol. The lacquer thus obtained furnished a stoving crackle lacquer exhibiting a high degree of hardness, adherence and acid resistance.

Acid resisting pigments for colored varnishes and lacquers are chromium oxide, titanium dioxide, graphite, carbon black, etc. It is sometimes impossible to supply acid resistant single pigments or even simple mixtures of a certain specified color tint, and the producers are often tempted to fulfil these specifications exactly even if the pigment or one constituent of the pigment mixtures required are not entirely acid resistant. This practice is not recommended, however, even if it is attempted to counteract the lessor acid resistance of the pigments in question by providing correspondingly more resistant vehicles, etc. Perfect results can only be attained if all conditions are satisfactory, and if the specifications call for properties unable of attainment (especially special tints) the specifications must be changed accordingly.

The methods of producing colored varnishes and lacquers must be adapted to the pigments used. Very resistant and good looking black varnishes using carbon black are obtained as follows: 500 parts by weight of alkyl resin, modified with 50 percent of fatty acid, 30 parts of carbon black (preferably active carbon black), 215 parts of benzene and 30 parts of triethylen tetramine. Another mixture is: 500 parts of alkyl resin modified with 28 percent of nondrying fatty acid, 3700 parts of antimony oxide, 80 parts of active carbon black, 215 parts of benzene and 30 parts of triethylene tetramine. This mixture forms a very useful basic material for acid-resisting varnishes and lacquers.

For instance, 100 parts of this mixture are stirred into 800 parts of a 25-percent nitrocellulose solution with 200 parts of butyl alcohol, 100 parts of alkyl resins and 68 parts of dibutyl phtalate. The product yields colored films of maximum acid resistance, exceptional depth of coloration, high gloss and a high degree of durability. Their resistance against mechanical stresses such as scratching, blowing, etc., also fulfils all requirements.

> It is necessary in any case to use acid resistant pigments dispersed with a number of non-substituted NH_2-groups in presence of one or more stable amines.

Phenol resins are most generally used in Europe for the production of acid resisting varnishes, especially for the treatment of sheet steel containers of all kinds, for pipe lines, ice box units and for the varnishing of practically all light metal surfaces. They are also used for acid-proofing wood, displaying a high degree of non-combustibility, high gloss and adherence as well as a high degree of resistance to prolonged exposure to water and organic solvents. If films of these special phenol resin products have been thoroughly hardened they are practically insoluble and unmeltable.

Where these products are used for stoving purposes it is absolutely necessary for the atttainment of maximum resistance to acid substances to stove every coating for itself. While every coating

must be free of pin-holes, pores or hair cracks maximum attention must be paid to the top coat. In order to obtain perfect safety in this respect it is a general custom to apply a top coat consisting of a clear chlorinated caoutchouk lacquer made from natural or synthetic caoutchouc.

It is not the purpose of this article to discuss the application of these substances in great detail. However, since the successful application of these products depend on the satisfactory preliminary treatment of metallic surfaces, it may be of interest to cite at least the most important requirements:

1) Metallic parts to be varnished should be heated in a vacuum or in a hydrogen atmosphere at temperatures of from 575 to 850° Fahrenheit in order to eliminate the deterious influences of inclusions.

   This is possible only of course, if the heat treatment does not interfere with necessary mechanical properties of the parts themselves. In any case, the heat treatment must be adapted to the mechanical properties of the parts to be varnished or lacquered. Where even comparatively low temperatures exert a deteriorating influence, etching should be applied to obtain perfect resistance of the coatings.

2) Etching of metallic surfaces as a preliminary step for acid-proof painting should be effected in two steps (in contrast to common practice). These steps are:
   a) Four hour dip in a solution containing 10 percent ferrochloride and 20 cubic centimeters of a 2.4 normal hydrochloric acid solution per Liter.
   b) 2-5 minutes dip in a solution consisting of 5.5 percent of hydrochloric acid, 40 percent of sulphuric acid and 24.5 percent of water. Instead of 30 percent of hydrochloric acid, 29.5 percent hydrochloric acid and 0.5 percent of nitric acid are frequently preferred. Temperature of the first solution: room temperature (60-70 degrees Fahrenheit), temperature of the second solution: 140-175 degrees Fahrenheit.

3) The pickling treatment described is not supposed to be a descaling or degreasing treatment. It should be applied only to completely degreased and descaled surfaces.

4) All conditions of storage, application and general treatment of the films being satisfactory, high grade acid-proof paints and varnishes should yield the following results:

   The films should not be affected seriously by subjecting them for one hour and at temperatures of 200 degrees Fahrenheit

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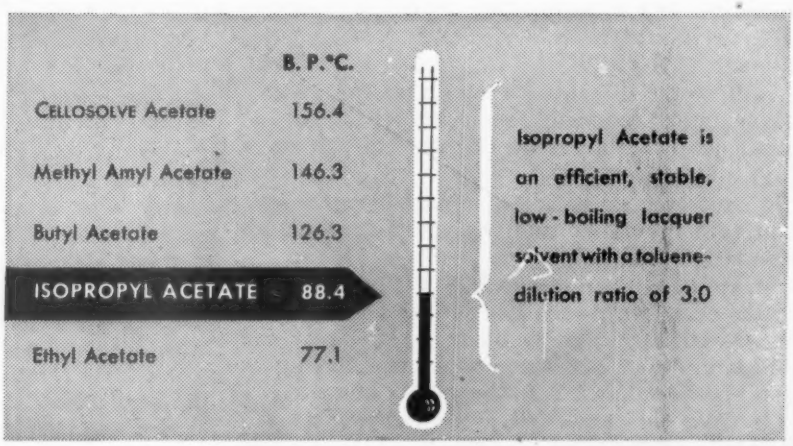
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to the following reagents:

Sulphuric acid, 50-55°Bé (spec. Weight 1.530-1.615 Hydrochloric acid solution, 18-38 percent. Nitric acid solution, 30-50 percent.

After this one hour treatment the films should remain completely resistant—without any appreciable changes—for many hours under the same corrosive conditions.

PIGMENTS-DISPERSION AND PIGMENTED PRODUCTS FOR LACQUERS AND ENAMELS*

By JEAN CROUET, Chemical Engineer, Technical Director of Etablissements WEEKS, Paris

Lacquer and enamel manufacturers have always been very interested in the possibility of keeping in storage defloculated pigments, ready to be incorporated by single mixing in nitrocellulose or synthetic resin solutions. It is a well-known fact that floculation frequently occurs when an attempt is made to keep in storage ground pigments. For instance, it is difficult to prevent floculation, after a few days or weeks, in a batch of carbon black, plasticizer, solvent, resin solution, etc., which have been ground in a steel ball mill. The result of this floculation is pigment separation from the vehicle, agglomeration, dull finish, and a poor grayish tone in the black dry film. The same may be said about pastes ground out on roller mills, flat stone mills, etc., though it seems that these plates exhibit better stability than ball mill ground batches. With certain pigments gelation might occur as a result of floculation.

The degree of pigment floculation can be evaluated by many methods of control:

Microscopical examination of the liquid lacquer or enamel, and of the dry film, are qualitative tests which give rapidly an idea of the degree of floculation.

Sedimentation control shows that the greater the volume of sediment, the lower the wetting and consequently the lower the degree of dispersion of pigment particles.

Thixotropy can be considered as being in relation with floculation and can also be taken as a measure of floculation.

Brownian motion has been said to be influenced by the degree of floculation. It appears that certain restrictions must be made, as Brownian motion is in direct connection with molecular agitation and also that it is influenced by viscosity.

Dilution tests have been made by Price, Khomikowsky, and Rebinder, to study the dispersion degree, by measuring resistance to floculation.

The above methods can only detect a high degree of floculation and more accurate tests must be developed. We will describe further a spectrophotometrical method which we have used with carbon black dispersions.

The objections about floculation, during the period of storage, of ground pigments have been overcome by the use of certain dispersing agents in appropriate amounts. We have shown in 1932 that if pigment particles are surrounded with a monomolecular layer of fatty acid like oleic acid, these particles become defloculated. In such monomolecular layers, the molecules are oriented so that they exhibit their carboxylic group on one side and their methyl group on the other. Several authors have confirmed the fact that such coated particles bear electrical charges of the same sign, which make them mutually repellent to each other.

We have shown that a monomolecular layer of fatty acid on the particles is critical and also that particles bearing coats of several molecules in thickness, do not bear electric charges of the same sign and have not the same degree of floculation as those which are monomolecularly coated. Such coated particles are incorporated in a part of the viscous non-volatile constituents of the end product, for example nitrocellulose, if the end product is a lacquer, or synthetic resin if the end product is an enamel. This semi-ready material can be worked out in paste, chips or any convenient shape or form, ready for mixing with the remaining constituents of the lacquer and enamel.

The characteristic feature of such a pigmented basis made from pre-treated pigments is that it can be kept in storage for a long period of time without showing any sign of floculation. Control methods above described do not reveal any pigment floculation in lacquers made out of such pigmented basis (pastes and chips) kept in storage since 1930 and worked out at this time with monomolecularly treat pigments. Pastes elaborated at the same date with same but non-treated pigments show a completely floculated state.

It has been noticed that nitrocellulosic chips made with high color carbon black pigments non-treated, or treated with an unsuitable amount of wetting agent, do not give a high color black lacquer. If the same pigments are treated in such a way as to provide them with a monomolecular layer of certain substances such as oleic acid, a great improvement in color is obtained. Typical color difference between two sprayed panels made with lacquer containing treated and untreated pigments can be easily noticed by any skilled eye.

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* This paper was presented before the Twenty-sixth Annual Meeting of the Federation of Paint and Varnish Production Clubs, Chicago, Ill., for publication in the *Official Digest* of the Federation of Paint and Varnish Production Clubs and is published by their permission.

It has also been noticed that during storage of a pigmented base such as carbon black chips, the initial high grade black color often gives place after a few weeks, to an unsatisfactory black color. This fact is due to floculation which occurs during aging. On the contrary, if chips are made with pigments coated with monomolecular layers, as above described, and kept in stock a long period of time, it is not possible to notice an adulteration of the original high grade black color.

Tests have been made to prove these facts and measurements have been taken with an improved spectrophotometer. As it is well known, the examination of black surfaces with a spectrophotometer is not easy, as this color is characterized by a nearby absorption in all the spectrum bands. Mr. J. Gillod of the Laboratories d' essais du Conservatoire des Arts et Metiers of Paris, has developed an apparatus having the following characteristics:

1. The light diffused by a black panel is analyzed by a double prism system which practically eliminates the errors caused by diffusion within the optic system.

2. It is very important in the case of black examination where the amount of light diffused by the panel is low, to have an exact proportion between the amount of light which strikes the electric photo cell and the electric current given by this cell. Generally electric cells do not give this desired exact proportion. This is due to the fact that the anodic potential of from 30 to 200 volts generates ionization of the residual gas in the vacuum tube causing a disturbing current. Mr. J. Gillod has overcome this disturbance by using cylindrical pure nickel anode at one end of which is placed a silver disk-shaped cathode coated with coesium. The cylindrically shaped anode acts as a Faraday cylinder and saturation is attained at a low potential of 2 volts or less. Under such conditions the variance in the proportion between light striking the cell and current delivered is very low. When the amount of light varies from 1 to 50 units, the error introduced by the cell is less than 1/1000.

3. Special features have also been made by Mr. J. Gillod for the amplification of low potential currents.

4. The initial light which strikes the examined panel is generated by a tungsten vacuum lamp using a 12 volt direct current.

Examinations of three panels were made with the improved spectrophotometer of Mr. J. Gillod. Ten measurements were made in each of four bands of about 10 millimicrons width in the following wave length:

440 millicons (purple)
527 millicrons (blue green)
618 millicrons (orange)
744 millicrons (dark green)

The average values of measurements in each band are given in *Table I.*

Panel A was sprayed with a lacquer made with chips containing carbon black pigments treated with a monomolecular layer of wetting agent. The

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chips were kept six months in storage before the manufacture of the lacquer.

Panel B was sprayed with a lacquer made with chips containing same carbon black pigments, as in panel A, but without treatment by wetting agent. The lacquer having been made a few hours after the chips were manufactured.

Panel C was sprayed with a lacquer made with same chips as panel B, but these chips were kept in storage during the two months before the manufacture of the lacquer.

In all three cases, chips, lacquer, and spraying of the lacquer were made according to same process. The lacquer was formulated similarly to Ford specification for nitrocellulosic body lacquer.

Table I

Diffusion Value	Wave Lengths 440 m.m.	527 m.m.	618 m.m.	744 m.m.
Panel A	0.475	0.460	0.470	0.540
Panel B	0.730	0.730	0.700	0.720
Panel C	1	1	1	1

The diffusion values of Panel C were taken as term of comparison. Diffusion values of Panel A are about half of the corresponding diffusion value of Panel C and diffusion values of Panel B are about three quarters of the diffusion values of panel C. This is a confirmation of the eye examination of the panels which had classified the panels in the following order:

A. High grade black color
B. Medium grade black color
C. Poor grade black color.

The difference of color between A (treated pigments with a wetting monomolecular layer of wetting agent) and B (no wetting agent) is relatively high and this difference increases considerably if the chips made with untreated pigments are kept in storage two months. It must be said that it was impossible to detect any variation of color between Panel A and a panel made with a lacquer manufactured with chips containing treated pigments, the dissolution of the chips having been made two days after their elaboration.

Conclusions

1. A spectrophotometric method can be used to study the degree of dispersion of carbon blacks.

II. Dispersions of carbon black pigments bearing a monomolecular layer of wetting agent give a high color black.

III. Chips made with monomolecularly treated pigments can be kept in storage a long period of time without loss of the high black initial color.

IV. Chips made with untreated pigments do not give the same high black color obtained with treated pigments.

V. Chips made with untreated pigments show a loss of color after a few months of storage.

PROPORTIONING EQUIPMENT AS RELATED TO WEIGHT MEASUREMENT*

By J. R. HANLEY, Toledo Scale Company

We should like first to clarify the designation of "proportioning equipment" so we may confine the discussion to batching operations as distinguished from continuous proportioning. While there is a pronounced trend toward continuous proportioning and continuous production in many divisions of the processing industries, I know of no manufacturer of protective coatings who is set up for continuous manufacture of one product based on one formula so as to require continuous or even semi-continuous proportioning as we understand the term. A batching job requires no definition. As examples of continuous proportioning we might mention the preparation of concrete for very large structures, with the several aggregates, the cement and water delivered continuously and in controlled proportions by specialized weighing devices, often in combination with flow meters; or the manufacture of glass, to a formula unchanged perhaps for years.

The modern weighing scale, in combination with the many control devices which can be used with it, or with weight-printing or recording devices, or both, appears to fit nicely into the present trend toward the "automatic factory." The use of automatic or semi-automatic weighing and control equipment is increasing because its employment helps users to realize some or all of these benefits:

1. Elimination of the "human element" causes of errors in many important processing operations.
2. Closer control of many phases of operation, and more uniform end products.
3. Closer measurement of yield.
4. Substantial labor savings.

The modern weighing scale, properly installed and serviced, is capable of a high degree of precision in measurement of loads. Such precision and sensitivity are important factors when batch ratios may be critical, proportions closely controlled. As an example of a requirement for such precision measurement we might cite the preparation of an adipic acid compound, used in making

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certain alkyd resins. The critical pH control requires measurement accurate to within about 1/25 of 1 per cent. While this may be regarded as an extreme case, it is not unusual to encounter requirements for accuracy to within, say, plus or minus 1/10 of 1 per cent. Weighing scales are of course not affected by changes in temperature, or changes in viscosity of liquids to be weighed, except perhaps for the time required to load or unload.

It is in order to repeat here the previous reference to proper installation and servicing to achieve the indicated degree of accuracy. Another important factor influencing the weighing machine is the pipelines leading to and from the weigh-tanks. Since it is usually impractical for us to ask for complete isolation of tanks, with no lines in actual contact, the use of good flexible connections and correct locations of lines are recommended to allow the scale to function properly.

Granting the inherent accuracy of the weighing device, we still have to realize its advantage. With manual control of operation, a careless worker can defeat our purposes and perhaps ruin a batch simply by failing to close a valve or stop a feeder when he should. It may be impossible to trace the trouble back to the individual. Even so, it may not always be due to pure carelessness. An operator may have another task to occupy him at the precise moment when he must be alert to shut off the feed; or the feed-control device itself may be at fault. So comes the demand for the controlled weighing operation — or perhaps for a permanent record, such as printed weight figures, which will give us significant information that the required quantity was or was not weighed correctly.

Controlled Weighing Operations

The simplest controlled weighing operation with which we are concerned may involve delivering one material—a liquid or a solid—in the correct quantity. This basic control may be effected by several means, the correct selection based on the degree of precision required. The familiar mercury-tube tilting or trip switch, used with the familiar beam-type scale, can open or close a circuit, close a valve or stop a feeder. It is important, however, that such devices shall not impose any friction load on the scale, thus impairing its accuracy. The use of the photo-cell and associated devices frequently offers a far superior means of control. The photo-tube is particularly adaptable to the dial-type scale with its moving indicator and the interruption of a light-ray by a moving indicator is entirely frictionless. Further, this combination of moving indicator and photo-cell allows us considerable latitude in controlling delivery of material in a way and at the rates of feed or flow to get maximum precision of measurement. We can provide two or three steps or stages of control. Let us assume it is required to deliver, say, one thousand pounds of liquid to a tank, and that the scale with its controls has been adjusted for this load. The "start" switch may open a two-step valve to full open; allowing the fluid to enter the tank at maximum rate. When the load reaches something near but less than the required

thousand pounds, the moving indicator (or interceptor, as it is called) will cause the light-cell circuits partially to close the input valve; the last few pounds are fed slowly so that final cut-off is precise. The two-stage valve could of course be replaced by two ore more controllable valves of different and correct sizes to allow throttling or tapering the end-flow for a precise cut-off.

Feeding a solid is a similar operation. A suitable controllable mechanical feeder delivers at high speed with tapered end-feed controlled in any of several ways—as by slowing down a vibrating feeder, cutting in the low speed of a two-speed motor driving a screw, stopping a large feeder or screw, using a smaller parallel unit for the end-feed, all with the required number of rate-controls to achieve required accuracy. Obviously this method also offers the advantage of time saving, along with precision in accumulating the load or batch by allowing the pumps, pipe-lines or mechanical feeders to deliver materials at maximum rates until accumulation of possibly ninety-five per cent of total load.

Perhaps this is a proper moment to call attention to certain other advantages of the dial-type scale for these weighing operations. First is the fact that the dial scale is self-checking in several ways. A glance at the indicator during the no-load interval will tell us whether the tank is empty before we start to load. Looking at the indicator during the loading interval will tell us the load is flowing for the idicator will continue to move as the load increases. With the flow or feed cut off, a glance tells us the correct quantity has been weighed. Another important advantage is that the dial scale permits the use of a no-load switch or control. This device can be arranged for control of important functions, chief of which might be to make it impossible to start the feed until the tank is empty and the indicator at the zero mark on the dial of the scale. It can also be interlocked so the feed or flow into the tank cannot be started unless and until the discharge valve in the line from the tank is closed. Control at no load, while often overlooked, is equally important as control at end load for if we start with an unwanted part-load the end load can not be accurately measured.

Accumulating two or more elements of a batch —liquids or solids or a combination—involves only an elaboration of the single-element automatic weigher described above. For a two-element batch we might use two interceptors, each positioned for a given quantity. Incidentally, these interceptors are usually in addition to the conventional weight indicator on the dial, so the scale may be checked at any time or for any load to make sure the loads are weighed correctly. It is not an unusual matter to have up to six interceptors, allowing for controlled accumulation of a six-element batch. Further, since the scale can be built with two dials, it is routine to have one group of interceptors on one dial for one formula, the second group on the other dial for a second formula. Use of external selector switches can often be worked out to handle more formulas, as by cutting out one element entirely, by running in a "back dial" element, and so on.

Equipment of this type lends itself nicely to associated control operations. Proper circuit arrangement, with a timer, can be worked out to suspend the loading of the scale after two elements, say, have been accumulated, when the agitator or mixer will operate. When the timer circuit stops the mixer motor, additional elements may be added. It may be necessary to hold a partial batch for temperature rise, with automatic resumption of cycle at correct temperature. It is not difficult to work out interlocked circuits to set up for agitation and/or temperature adjustment in the automatic cycle.

To achieve closest possible control of the weights of all elements going into a batch it may be advisable to use two or more scales. This is particularly true when certain elements may consist of only a few pounds each, as compared with the weights of the major, heavier elements. It is not to be expected that we can weigh a 50-lb. increment in the tank of a scale with a dial of perhaps five or ten or even fifty thousand pounds capacity with the required accuracy. It is often the case that these small, light loads are those requiring utmost precision of measurement. So at times a batching plant or unit may consist of several scales, each with its own controls, all interlocked to provide completely automatic operation both as regards loads and sequence.

A rather notable example of an efficient multiple-scale batching plant is one recently put in operation by a prominent manufacturer of paints, resins, plastics, etc. For this job we worked out with our client an arrangement of three small and two larger scales. Two of the small scales weigh dry granular materials; one weighs liquid accurately in small quantities. The dry materials, stored in bins, are fed to weigh-hoppers by vibrating conveyors, with two-speed control of feed. Liquid is delivered to the small weigh-tank through a valve controlled by the scale, with a controlled discharge valve. The larger weigh tanks accumulate ingredients in accordance with required segregation or separation to prevent premature mixing. Each small scale discharges its weighed load into the correct large tank at a predetermined step or stage in the over-all batching operation.

With the several scales pre-set to formula, the operation is entirely automatic. The small scales take on their loads. Certain elements are weighed into the larger tanks. Agitators start and stop on schedule. The part-batch is brought to a required temperature, whereon other elements are charged automatically. The conventional weight indicator on each scale dial allows for visual checking of each step or phase. After each and every step has been completed, and after the entire batch, properly segregated, is in the two large tanks, a "batch

ready" signal is flashed. Then, and not until then, current is fed to the circuit handling the discharge valves, and the batch may be dropped when called for by another impulse or by use of a manually operated "discharge" button. Provision is incorporated for changing from one formula to another by use of selector switches. Provision is also made for quick changeover from automatic to manual operation if it is desired to run a special formula. One man supervises the operation. We are told the end-product resins are of superior quality, highly uniform and practically 100 per cent acceptable under rigid standards of inspection, testing and analysis.

Equipment of the type just described is employed most efficiently in plants working on a low diversity, high volume per formula, pattern of production. We face far different conditions in the high diversity plant, where a different formula may be used for each batch. We must also modify the automatic operation when the dry materials, such as pigments and fillers, are received, stored and handled in bags, and cannot be stored in and mechanically drawn from bins. So we find many spots where some weighing operations must be

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manually controlled, or where some operations may be automatic with others necessarily manual. On such jobs the weight-printing device may be used to advantage.

Printed Weight Records

Let us accumulate a very simple batch consisting of, say, 1410 lb. of a pigment, 348 lb. of linseed, 260 lb. turpentine, 16 lb. naphthenate dryer solution—total weight of batch 2034 lb. Pigment is stored in 50-lb. bags. A batch-card is made up for this indicated sequence, showing the required amount of each ingredient and the cumulative total weight after each step. Pigment weighing 1400 lbs. is taken care of by using 28 50-lb. bags. The odd ten pounds may well be weighed on a small scale at the pigment weigh station. The entire load is brought on a pallet to a mixer-tank on the scale, dumped into the mixer. The weight is printed on a ticket or strip, simply by pushing a switch button. The linseed is run into the tank, the valve closed with the scale indicator at the 1758-lb. mark on the dial (1410 lb. pigment plus 348 lb. oil). This weight is printed. The turpentine is added and cut off with the indicator at the 2018-lb. mark on the dial (1410 pigment plus 348 oil plus 260 turpentine), and this weight is printed. The dryer solution might be valved in, or the premeasured small load may be dumped in manually. The final weight record should be 2034 lb. The weight figures are a permanent record. It is a common practice to print them right on a properly designed batch order ticket—or the strip record may be stapled to the batch order.

The scale may be equipped with devices to identify the various elements in the batch. The identifying symbol, or number, is printed beside the weight figures. In the busy plant the automatic ticket-shifter may be used to re-position the ticket for the next weight-printing Batch cards of different colors have their uses.

If we must load certain elements manually yet desire to add others by automatic or semi-automatic control, it is usually possible to work out practical schemes for operating, with the printed record telling us the complete, concise story about the accuracy of measurement of each element. Knowledge that the printed record is being made may keep the workman "on his toes" and minimize errors, rejections or re-workings caused by careless work.

We might touch briefly on the subject of controlling the rate of flow, using the conventional dial scale, although we encouter this problem more often in nitration and other conversion jobs than we do in the paint and varnish industry. However, it may be required to discharge a quantity of liquid at a pre-determined rate, or at a rate varying automatically in accordance with formula requirements. We have worked out several such devices with the assistance of clients and of manufacturers of controllers, metering devices, etc.

One development employs our dial scale on which is mounted the Taylor Fulscope Time Schedule Controller, together with other controls for weighing and switching. The required load of fluid is weighed in the tank. The cam on the controller is cut for the required flow rate—fixed or variable. There is a simple mechanical linkage between scale mechanism and controller mechanism. As the fluid leaves the weigh tank, the controller directs the action of a diaphragm valve. By throttling the valve the controller pen arm and the scale indicator are kept in step or phase. With a closed tank, as used in feeding latex, this device may control in two ways—by adjusting the air- or gas-pressure in the tank, and by throttling the discharge valve. This combination offers interesting possibilities.

Another device which adapts nicely to the dial scale for control purposes is the electronic transmitter made by the Bailey Meter Co. Essentially a coil within which an iron "core" moves, the iron "core" is fastened to a moving part of the scale. Moving the core influences the current within the coil. Since this element will respond to a core-movement of as little as 1/50,000 in. (0.00002 in.), and since the current-variation may be used in several ways, this combination can be used for control or remote indication and recording.

Another device which has interesting possibilities for certain weight control and feeding jobs is the pneumatic transmitter, such as that made by Fischer and Porter. Attached to a part of the dial scale linkage, where the motion is linear or approximately linear, this device can use air pressure changes for a number of useful purposes.

Because we encounter such widely diverse conditions and requirements in your industry we are constrained to discuss our subject only in a general way. Each plant or process must, of course, be regarded and studied as a specific problem. We do feel safe, however, in offering the general statement that your industry provides many interesting opportunities for the profitable use of well-designed, functional, weight-control equipment.

FOREIGN PATENTS

DILUENT FOR SILICATE PAINTS. French Pat. 875,881. Utilisation des Minerais Complexes. Applied for Sept. 13, 1941; delivre July 7, 1942. Diluents for paints based on silicates are produced by treating siliceous raw materials containing few impurities (such as alkaline earth bases, alumina or iron oxides) with boiling potassium hydroxide and then adding a convenient quantity of sodium silicate.

FILLING AND PACKAGING*

By G. R. STEVENS, Elgin Manufacturing Company

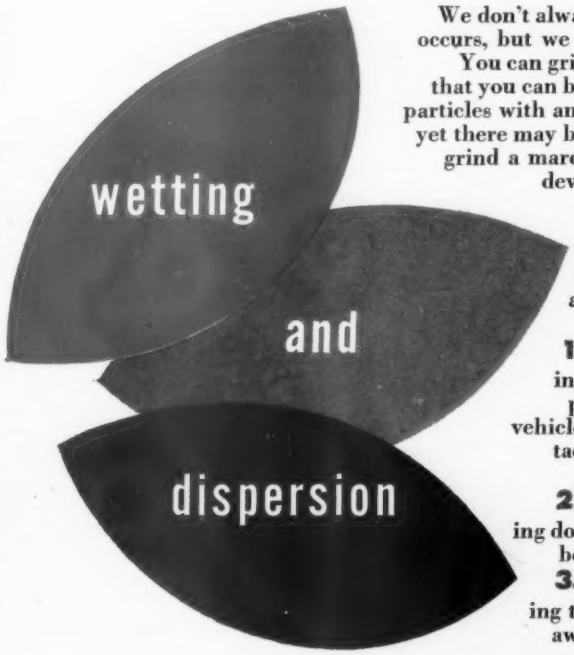
Prior to 1932, only 16 years ago, filling and packaging of paint had been done by hand, or by machines designed for other purposes. In that year the first machine specifically designed for filling paint was produced. We have gone a long way in 16 years to our present automatic machines for accurately filling and packaging paint.

Let us first consider in the filling of paints, the correct type of machine. In the filling machine industry there are three basic types of filling machines—vacuum, gravity, and plunger. I have not heard of paints being filled by vacuum; the reason of course is that vacuum filling is fine for free-flowing liquids, but for products of varying weights, and as heavy as paint; the method is not practical on account of slowness of fill with heavy products, and gumming up of vacuum tubes which are small.

In the gravity-type machine, the product is either pre-measured and then flowed by gravity to the container, or flows to the container by gravity, and is measured in the can by the operator's eye, or by weight. I feel that measurement by weight is fundamentally wrong, as we all know that paint varies in weight, even between batches of the same product, and paint is sold by the gallon, which should be the unit method of filling. Then the measurement of the fill by eye—we all know the sharpness of even the best operators varies from day to day and even from hour to hour. Let us assume a real good operator can tell the fill of a can to 1/16 of an inch, and that is mighty close. If they short fill, you are likely to get in trouble on short measure, and if the 1/16 is on the long side, it means—say on a half-pint size, you are giving away one can in 40, and if you are filling 40 cans a minute, it means 60 cans per hour, and in an 8-hour day, 480 cans, or 30 gallons of paint—and that is a considerable amount. I do not feel either, that the general run of paint, even though automatically pre-measured, should be filled by gravity, as by this method, gravity regulates the speed of discharge and paints can be handled much faster than by gravity.

This brings us then to the plunger-type machine. With this type, the paint is measured in a cylinder, or cylinders, of fixed diameter by the stroke of a piston which is automatically operated. The stroke of the piston is adjusted by a micrometer screw which can be accurately set, marked, and re-set.

* This paper was presented before the Twenty-sixth Annual Meeting of the Federation of Paint and Varnish Production Clubs, Chicago, Ill., for publication in the *Official Digest* of th Feederation of Paint and Varnish Production Clubs and is published by their permission.



We don't always know why wetting occurs, but we know it's important. You can grind a pigment so small that you can barely see the pigment particles with any optical instrument, yet there may be no gloss. You might grind a maroon forever, trying to develop an eye-catching, clean color, yet all you get is something dull and dirty. Putting pigment into a lacquer successfully involves:

1. *Wetting*, or displacing the air around the pigment particle with vehicle and developing contact of the vehicle with the pigment.
2. *Grinding*, or breaking down the cohesive force between particles, and
3. *Dispersing*, or moving the pigment particles away from one another into the vehicle.

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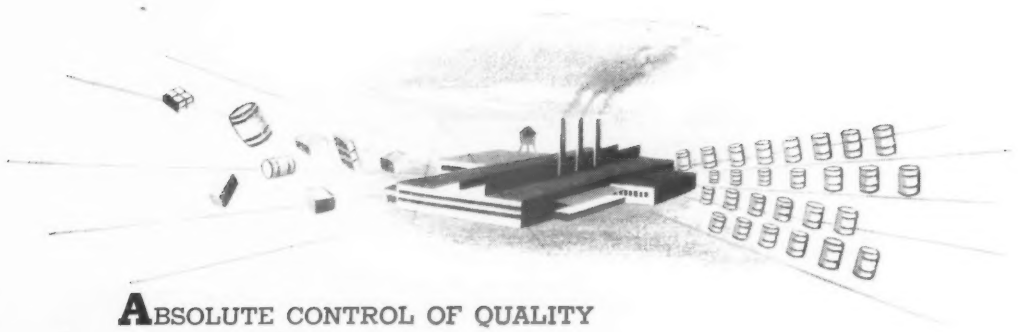

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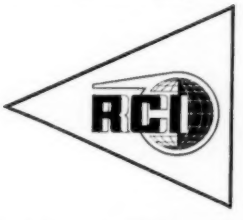

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On one machine I know the pitch of this micrometer screw thread is 16 threads per inch, so that 1/16 of a revolution of the control wheel changes the piston stroke 0.0078 in. The cans can be filled accurately without wastage. The piston being mechanically controlled displaces the same amount of paint each stroke, and will fill each can the same. With this type of machine the velocity of paint entering the can can be controlled—much faster than by gravity—and can be operated at maximum speed, depending, of course, on surge and splash conditions which vary with various paints. Some machines use a nozzle discharge and others use a perforated disk to break up the stream and minimize surge and splash. Automatically controlled cut-off plates at the nozzle, or on top of the perforated disk, practically eliminate drip. Accordingly, I feel that the plunger-type machine, whether it be single valve or high speed rotaries, is the correct type of machine for filling paints.

This brings up the question of when should we go to automatic filling. The most exhaustive and complete study of this subject I have seen is the report of the Plant Manager's Committee of the New England Paint & Varnish Production Club, published in the January issue of the OFFICIAL DIGEST, page 108. This committee was composed of Harold S. Ellsworth, Arthur J. Anderson, Richard W. George, Cole D. Neff, Henry B. Twonbly, and Stewart O. White. This committee sent exhaustive questionnaires to all parts of the country to paint manufacturers and to machine manufacturers, and from these questionnaires drew up graphs showing the break-even points between hand filling, semi-automatic filling, and automatic filling of all sizes between 16ths and gallons. These charts showed, naturally, a much lower break-even point on batch size on the smaller containers than on the larger. For instance on 16ths, automatic filling over hand filling at 40 gallons, and automatic filling over semi-automatic filling at 60 gallons. These studies took into consideration set-up time, filling time, and clean-up time. They assumed, as they naturally must in such a study, the same accuracy of fill on all methods. However, I cannot agree on this point, as I brought out in my discussion on gravity fillers, which are the hand and semi-automatic types considered. The break-even point means more than the set-up time, filling time, and clean-up time; it must consider accuracy of fill, and accuracy of fill can only be obtained by automatic filling. Also that report is a year old. Materials have gone up; labor has gone up; and as far as I know, automatic filling machines have *not* increased in price. So I say, with conditions as they now are, and appear to be in the future, accuracy of fill is all-important, and can only be obtained by automatic filling.

Within the last few weeks it has been my privilege to go through several paint plants large and small. Frankly, I wanted to get some actual field experience for this talk. I was amazed to find the serious study being given to plant layout and mechanization. Of course it is natural with today's labor rates, but paint manufacturers are

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doing it. Such functions as all-gravity flow, segregation of like equipment, and warehousing arrangement and handling, even automatic flushing for tanks, pipes, and machines; this industry is really in the mechanical era.

I made some observations of floor space in one really modern plant which may be of interest. These are percentages of manufacturing area:

Empty can and carton storage, 11 per cent; raw material warehousing, 24 per cent; mixing tanks, 7 per cent; grinding mills, 7 per cent; finished goods warehousing and shipping, 48 per cent; and filling and packaging, 3 per cent.

Just imagine 3 per cent of the total manufacturing area for filling and packaging. It could not be done without automatic accurate filling. The relative area required is so small, many concerns do not give it the serious consideration it requires, but oh, how wrong! Let's think this one over. With filling and packaging area about 1/20 of warehousing space, is it not good sound economy to increase filling and packaging space to reduce warehousing space in the proportion of 20 to 1? One very progressive paint manufacturer with 2500 items, who has made a study of this subject, has three times the necessary filling and packaging equipment with ⅔ of it idle to permit short runs according to orders received, and accordingly reduce warehousing space and capital in inventory. The savings are several times the depreciation on the idle machines.

So far I have not mentioned capping paint cans, but I think that is part of the subject; I doubt whether anyone is still pounding covers on with a wooden mallet. I haven't seen it for some years and let us hope that is a thing of the past. There are three types of closing machines — one where the cover is pushed down by a flatter in one stroke; one where the cover is squeezed home between two conveyor chains, and one type where it is done in two operations—starting the cover and seating the cover. The first two methods generally have a tendency to trap air in the can under pressure, which may result in bulging cans and leakers. The latter method by two step rollers, I feel, is preferable. The first roll forces surplus air out of the can and the second roll seats the cover.

The placing of covers between filling and capping is a simple operation but it requires an operator who could be better employed by feeding cans for foster operation. There is an automatic cover dropper quickly adjustable for all sizes, which automatically places the cover on the can in the same machine which fills and seats the covers. This is another labor-saving machine for this high cost labor age.

I should like to give you a few cost figures on filling and capping on one of the automatic machines with which I am familiar. I worked this up on a production cost estimate sheet I have used for a number of years. I found one which I made in 1940 and there were two interesting general comparisons. On the cost of the machines which includes automatic filling, cover dropping, and capping, the price has increased 34 per cent, which barely covers the mechanical improvements made in the machine in that period, but what

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really surprised me was that the labor rate increased 108 per cent. The only way to fight this labor increase is by automatic operations.

Just a word about new equipment for filling and packaging of paints and I will discuss only plunger-type machines. There is now available an automatic machine for filling and seating the covers on containers from 1 gallon to 5 gallons. There is an improved model of a machine which automatically fills, puts on the covers, and seals containers from 32nds to gallons. This new design permits higher speeds on the gallon sizes. An adaptation of this machine incorporates equipment for automatically crimping covers on cans. Then there is a new high speed rotary filling machine on small sizes. A little off the strictly paint line, but I am sure many of you package show card colors in small bottles. A small machine is available for accurately filling these at enormous savings in filling costs.

I believe the machinery manufacturers have kept abreast of requirements of the paint industry for high speed, accurate filling and packaging. We are always ready and willing to cooperate in your special requirements.

FILTERING AND STRAINING VARNISHES AND PAINTS*

By A. C. KRACKLAUER, Sparkler Manufacturing Company

Like so many other problems in the paint and varnish industry today the clarification and filtration of varnishes and lacquers, and the straining of pigmented enamels and paints is a rather comprehensive subject and could well involve us in interesting discussions lasting hours if we were to consider the many details and technicalities that the subject presents. Since our time is limited we probably can accomplish the most by confining our remarks to some of the fundamentals of the overall problem.

I believe that every paint and varnish manufacturer today is so fully aware of the importance of thoroughly clarifying paints and varnishes that we need spend very little time on this phase of the problem. We all appreciate that clarifying and filtering a varnish, resin or paint not only improves its appearance but its intrinsic qualities as well. For instance we know that filtering dirty insulating varnishes will improve their dielectric properties from 30 to 200 per cent, and their heat endurance 10 to 20 per cent. Or again a fine protective coating may be rendered pervious through minute dust or dirt particles present.

Before we discuss the specific problem of filtering varnishes, I think it is very worthwhile that we dwell a minute on the basic principle of filtration; because, as is so often the case, once we understand the theory, the application becomes almost automatic. Basically, filtering is the separation of fine solids from liquids or gases. If the solids are relatively coarse we usually refer to it as straining.

Up to about 50 or 60 years ago this separation was accomplished by means of a fixed septum or membrane having pores fine enough to withhold the solids to be removed, and large enough to permit the liquid to pass. It is easy to see what happened in those days when the solids being removed were of a colloidal or jelly-like nature as they so often are in varnishes or when the liquid being filtered had a high surface tension such as varnish.

In removing colors, odors and tastes from liquids by means of kieselguhr, or powdered charcoal the chemists of those days found that the throughput of a given filter area was increased somewhat when these powders were mixed with the liquid being filtered. The reason for this is the fact that the porous and crystalline nature of the charcoal particles tended to keep the slimy particles separated from each other as they were deposited on the filter paper or cloth. Some years later it was found that some of the diatom deposits in this country, due to their irregular shape, cellular construction and chemical inertness proved to be remarkable filter aids. Once this discovery was made the grading and purifying of these diatomaceous earths progressed rapidly so that today they are definitely the finest and most efficient filter aids that we have.

We can see from this that fundamentally the theory and use of filter aid is quite simple. The cellular, irregular particles of filter aid simply keep the jell-like particles in the varnishes separated as these particles are depositel on the filter paper, thereby keeping the filter area porous, and permitting the varnish to flow through much longer and at far less pressure. As these irregular-shaped, cellular diatoms are dispersed in the liquid being filtered, the jell particles in the liquid become attached to them so that when the diatoms are trapped on the filter paper they also trap the jell particles. For this reason and the fact that the diatoms are porous themselves and thus permit liquid actually to pass through their structure diatomaceous earth also acts as an efficient clarifying agent as well as an anti-clogging agent.

To take full advantage of the benefits of these filter aids however, some rather basic facts should be kept in mind, especially in the filtration of varnishes. Although these diatomite cells are quite

* This paper was presented before the Twenty-sixth Annual Meeting of the Federation of Paint and Varnish Production Clubs. Chicago, Ill., for publication in the *Official Digest* of the Federation of Paint and Varnish Production Clubs and is published by their permission.

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strong structurally, it should be remembered that they can be broken down and compacted either through velocity or pressure, or a combination of both. Good filter practice indicates therefore that the velocity and pressure should be kept relatively low.

It is always a strong temptation for the filter operator at the beginning of a cycle, when the filter is clean, the pressure is low, and the varnish is flowing fully and brilliantly to "give her the gun." This, however, frequently does not produce the maximum results or throughput. The reason being that if the mixture of filter aid and slim particles strike the filter bed with too high a velocity it tends to impact them too tightly, resulting in decreased cake porosity and decreased ultimate throughput. In my experience, most varnishes are filtered to best advantage at a maximum rate of 40 to 50 gallons per hour per square foot. Of course where it is a problem of merely removing coarse skins, scale particles, etc., this rate can be increased considerably.

Again, in filtering with diatomaceous filter aid we can defeat our own purpose quite easily with too much pressure because excessive pressure may break down the very filter aid cells that we have introduced to keep the filter bed porous. Here again it is quite a temptation for the operator to conclude that the remedy for a slowing up of flow rate is more and more pressure, whereas the remedy usually is more filter aid or occasionally a coarser filter aid.

From the foregoing outline of the use of diatomaceous filter aid it becomes obvious that the amount of filter aid that we use is of most vital importance. Because if the porous diatoms are to keep the slim particles separated there should naturally be enough diatoms to do the job or they'll get snowed under. The proper amount for varnishes can vary by weight from 1/10 to 1 per cent for a fairly clear and light bodied alkyd to 1 per cent by weight for a very dirty natural gum varnish or gloss oil. Most varnishes are filtered very successfully with ¼ to ½ of 1 per cent by weight of diatomaceous filter aid. Your filtration engineer usually can work these formulas out for your particular product with but a few trial runs.

It is not sufficient, however, to have merely filter aid in adequate quantity. It is just as important that it be properly dispersed. Here, the fact that varnishes are usually made and filtered batchwise is of great advantage to us because the best dispersion is always obtained, especially with a viscous liquid, by introducing the indicated amount of filter aid into the liquid and then thoroughly mixing it by means of mechanical agitation. I consider this business of proper agitation so important that I feel constrained to dwell on the subject for just a moment. Frequently it is not convenient or it may even require a substantial expenditure to rebuild a plant to obtain good agitation, but in the long run it is bound to pay out. This decision is, of course, nothing more or less than the familiar decision that management is called on to make so frequently today: namely, to engineer the job right from the start and make the necessary plant investment once and for all, or to keep throwing good dollars after bad year in and year out on makeshift plant and methods.

In dealing with a viscous liquid the temperature of the liquid and grade for (size) of the filter aid naturally are important factors. On the face of it, it would appear that within limits the higher the temperature and the coarser the filter aid the better. We find, however, that this theory is subject to some serious limitations. Even with present-day scientifically controlled cookers and refined raw materials we still find many varnishes that contain jell particles and microscopic colloidal suspensions. If these varnishes are filtered at too high a temperature, say around 250 F. these fish eyes may be in solution, pass through the filter bed and coagulate, after filtering, as the temperature drops. If these elusive fish eyes are a source of trouble to you try filtering at a low temperature —around 150 F. Again there are many hazy materials, particularly some synthetics that cannot be cleared up with the coarser grades of filter aid, and here a medium grade is indicated.

A varnish maker of many years' experience recently told me of a quick and simple method of detecting these jell particles in filtered varnish samples. Since this is not always so easy to do because these particles are transparent it might be of value to mention it here. He fills a standard Gardner-Holdt bubble tube with the varnish, then pours off about 2/3 of the contents, and when the remainder has cooled off, the tube is tilted and if jell particles are present they are visible on the walls of the tube.

Up to now we have considered the clear, cooked materials only. Spirit varnishes, or cold cuts, shellacs and pigmented materials require altogether different handling.

Spirit varnishes usually contain such a large amount of solids and have to be filtered at such a low temperature due to the volatile thinners that an altogether different approach is indicated. These materials frequently are first settled, and then decanted off and filtered. As a rule a very coarse filter aid and a filter with a large amount of area rather than cake space, such as a plate and frame, is preferred. The clarification of these materials naturally is always more troublesome and costly than it is with the cooked variety.

Shellacs, due to the coarse solids that usually are to be removed, are best filtered through a fairly porous filter paper, and without filter aid. Here, flow rates up to 75 and 100 G.P.H. per square foot can be obtained.

We have treated the whole subject of clarification so far from a standpoint of static filters rather than centrifugal clarifiers. To make the treatise complete we should mention some of the relative merits of these two methods. With the centrifugal clarifier it is not necessary to use filter

aid or a filter paper or filter cloth. Occasionally a centrifugal may be cleaned a little easier than some types of filters. A filter, on the other hand, usually has a much greater output capacity per dollar investment, and per dollar maintenance cost. It will do a much finer and sharper clarification of the more difficult to clean products in which the solids often have the same specific gravity as the liquid being filtered. A filter, especially the enclosed type prevents evaporation of volatile thinners.

In recent months considerable work has been done very successfully in the pressure straining of pigmented enamels and paints. The big problem here is to decide on the proper filter or strainer media for the particular job to be done. Up to the present, this has frequently been a trial and elimination process. However, certain types of synthetics, very porous paper and certain grades of felt that can be washed and re-used have proved very successful. Tremendous production increases have been made over the old-type bag strainer tied over the outlet pipe. And needless to say, a better and more uniform quality is being maintained. The choice of the filtering machine is important here—it should be easy to assemble and clean, and above all it should be so designed that any type of media that is indicated is readily interchangeable in the filter, be that felt, paper, cloth or wire mesh.

In the filtering of varnishes and paints it is always important to eliminate any unfiltered residue or heels at the end of a run. Usually this is accomplished by blowing the filter down with carbon dioxide gas. If your filter is of proper design this can done very successfully. This, however, should *never* be done with compressed air because it represents a very dangerous explosion and fire hazard, due to spontaneous combustion caused by friction of the air passing through the filter cake.

In my many years of association with the paint and varnish industry as a filter man I have seen the industry make many advances in the improvement of their products from a clarification viewpoint. In fact, I might have become a little impatient at times with your demands of perfection. I have caught myself saying more than once, these damn varnish makers simply expect the impossible. However, I want to assure you that it makes me very happy and very proud to share with you if only in a small way, your pride of accomplishment.

RECENT ADVANCES IN PAINT TECHNOLOGY

ORGANO-SILICON COMPOUNDS IN PAINT MEDIA. The author reviews recent advances in the applications of organo-silicon compounds in paint technology and proposes new methods for the formulation of silicon ester paints, which do not depend on a closely controlled hydrolysis process. H. G. Emblem. Paint Manuf. **17**, 239-240 (1947).

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NEWS AND REVIEWS

A revised edition of a technical booklet on Parlon, Hercules Powder Company's chlorinated rubber, now is available. The revised edition contains considerable new information on the use of Parlon in protective coatings, printing inks, paper coatings, textile finishes, and many other applications.

Parlon is an excellent fortifier for long-to-medium oil length alkyd enamels. The addition of Parlon gives a faster drying time, and in the case of force-dried or baked enamels, develop harder films which may be handled sooner.

Charts showing how Parlon speeds the drying time of enamels, and photographs illustrating the results of drying-time tests are included in the new booklet.

* * * * *

Substantial price reductions for FLEXOL plasticizers 4GO, TWS, and R-1 are announced by Carbide and Carbon Chemicals Corporation. The new prices, effective September 1, 1948, are 36 cents a pound for FLEXOL plasticizer 4GO in tank cars, 40½ cents a pound for FLEXOL plasticizer TWS in tank cars, and 47 cents a pound for FLEOXL plasticizer R-1 in drum carloads, f.o.b. South Charleston, W. Va. Increased volume of production is said to make these lower prices possible.

FLEXOL plasticizer 4GO is widely used in vinyl resins to improve processing characteristics and to impart a more desirable "hand" to finished products. This plasticizer develops excellent cold check resistance in nitrocellulose finishes and is a superior general purpose plasticizer for nitrile rubber.

FLEXOL plasticizer TWS is a new ester plasticizer of exceptionally low volatility and excellent heat stability. Vinyl resin compounds plasticized with TWS are characterized by high resilience. Nitrocellulose metal finishes plasticized with TWS exhibit greatly improved durability without sacrificing other desirable properties.

* * * * *

A phthalic alkyd resin, which does not haze in the presence of zinc oxide, has been introduced to the market by U.S. Industrial Chemicals, Inc., 60 East 42d Street, New York City 17. Known as Aroplaz 1248-M, the new non-hazing resin is another contribution of U. S. I. research to the protective coatings industry, and permits, for the first time, mirror-like finishes, with high-gloss and gloss-retention, even in the presence of zinc oxide.

The product, according to the manufacturer, is applicable for formulation of architectural paints and enamels, especially for use in mill whites for textile mills, and for all maintenance finishes. Aroplaz 1248-M is a pure, long-oil, oxidizing alkyd, supplied at 70 per cent solids in mineral spirits, and is the result of years of testing and development by U. S. I.'s laboratory and production experts.

Excellent film characteristics, and especially color-retention of the long-oil architectural variety, have made alkyd resins highly desirable for top-grade white enamels. Characteristic weakness of alkyds up to the present time, U. S. I. reports, has been their tendency to develop a surface haze giving the appearance of a thin film of chalk. This hazing tendency resulted in diminished gloss to the point of almost appearing flat when viewed at normal angles, and it was particularly pronounced when zinc oxide was used in pigmentation. As zinc oxide is absolutely essential to prevent yellowing of white enamels, hazing has been a serious drawback to the use of alkyds in such enamels.

* * * * *

The Eagle-Picher Company has just announced the release of an eleven page bulletin entitled, "Greater Economy in Metal Primer Formulations."

This bulletin discusses the use of more economical blue lead and red lead primer formulations for protection of iron and steel in atmospheric exposure. It covers briefly such important subjects as the problem of the Specification Engineer in selecting the best paint system; the choice of a vehicle composition which will give best results; surface preparation prior to painting; and, the question of quick-drying versus slow-drying paints. Detailed breakdowns of compositions, grinds and characteristics of each suggested formulation are also presented.

Copies of this factual bulletin may be obtained by writing The Eagle-Picher Company, Technical Service Department, Pigment Division, Cincinnati 1, Ohio.

* * * * *

"Organic Acids" is the title of a new booklet just published by Carbide and Carbon Chemicals Corporation. It presents in detail the properties, specifications, and uses of synthetic butyric acid, 2-ethylbutyric acid, caproic acid, 2-ethylhexoic acid, and sorbic acid. These acids are important as intermediates in the production of synthetic flavors, plasticizers, varnish driers, and pharmaceuticals. Thirteen charts in the new booklet present such data as physical constants, solubilities, and electrical conductivity. Constant boiling mixtures and a section on specification test methods are also included.

Copies of this booklet may be obtained from any office of Carbide and Carbon Chemicals Corporation. When requesting your copy, ask for Form 4768-A.

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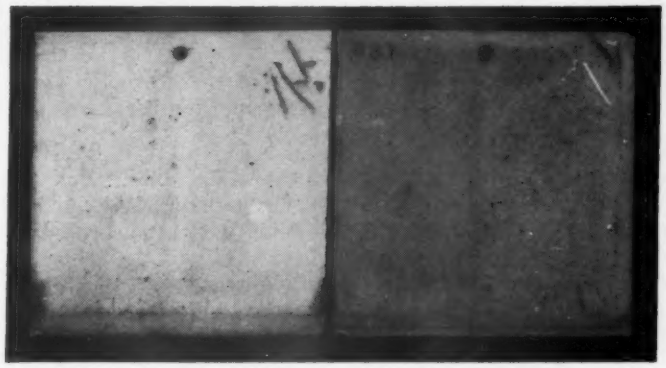

Unretouched photograph of maintenance paint with a Styrenated vehicle after 2½ years exposure.

Unretouched photograph of a high quality commercial maintenance paint after the same 2½ years exposure.

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FOREIGN PATENT DEVELOPMENTS

SOLVENT FOR LACQUERS. German Patent 725,802. A. Rieche and A. Gnuchtel (assigned to I. G. Farbenindustrie). Applied for May 8, 1938 (applied for in Austria April 28, 1938); granted Sept. 30, 1942. 3-Chloro- or 3-bromo-tetrahydrofuran (prepared by splitting off hydrogen chloride or hydrogen bromide from 3,4-dichloro- or 3,4-dibromobutanol) are patented as solvents in the production of lacquers and plastic masses.

ULTRAVIOLET LIGHT - FLUORESCENT COLORING MATTER. German Patent 724,186. F. X. Pohl (assigned to I. G. Farbenindustrie). Applied for Feb. 9, 1940; granted Aug. 20, 1942. The magnesium lake of the azo-dyestuff from diazotized 4-alkoxy-1-aminobenzene - 2 - sulfonic acids and beta-naphthol is used as a material to be incorporated in surface coatings and inks (e. g. with a linseed oil varnish) to impart the property of fluorescing red in ultraviolet light.

PRIMERS AND PUTTYING MASSES. German Pat. 711,831. O. E. Hintze (assigned to Rohm & Haas G. m. b. H.). Applied for July 28, 1939, granted Oct. 14, 1941. Mixtures of 40 to 85% of an ester of acrylic acid or methacrylic acid and 60 to 15% of acrylonitrile or methacrylonitrile in a suitable organic solvent are claimed as primers or puttying materials.

POLYMERIC LACQUER BASE. German Pat. 741,646. G. Loy (assigned to Firma J. S. Staedtler and G. Loy). Applied for Oct. 5, 1941, granted Nov. 15, 1943. The use of liquid monomeric easily polymerizable ethylene derivatives as a substitute for the usual organic solvents used in lacquer formulations is claimed. Suitable polymerizable materials of this type are monomeric methyl methacrylate or styrene.

IMPROVING POLYMERIZABLE OR OXIDIZABLE DRYING OILS. German Pat. 742,-519. W. Bunge and O. Bayer (assigned to I. G. Farbenindustrie). Applied for Dec. 4, 1940, granted Dec. 28, 1943. The stability of polymerizable and/or oxidizable drying oils such as linseed oil, tung oil or perilla oil in the presence of pigments is prolonged by heating the oil for several hours with 3 to 4% of a mono-isocyanate or a di-isocyanate such as phenyl isocyanate, cyclohexyl isocyanate, beta-naphthyl iso-cyanate, hexane-1.6-di-isocyanate or 1-chlorophenylene-2.4-di-isocyanate.

MODIFYING THE MOLECULAR STRUCTURE OF OILS AND FATS. Brit. Pat. 575,416. E. W. Eckey (assigned to Proctor & Gamble Co.). Applied for July 14, 1943 (applied for in U. S. Oct. 30, 1942); accepted Feb. 18, 1946. A process for altering the physical properties of fats and fatty oils and replacing fatty acids of lower molecular weight with those of higher molecular weight by subjecting a liquid mixture of a fat and fatty acid ester of a monohydric aliphatic alcohol having less than five carbon atoms per molecule to a temperature at which molecular change in the glyceride will take place, simultaneously vaporizing at least part of the monohydric alcohol ester present in the mixture, fractionating the vaporized esters, returning the less volatile fraction to the reaction zone to permit further reaction with the glycerides, and removing the more volatile fraction.

MANUFACTURE OF SYNTHETIC RESINOUS CONDENSATION PRODUCTS. Brit. Pat. 600,618. E. A. Bevan and R. S. Robinson (assigned to Beck, Koller & Co.). Applied for Jan. 31 and July 12, 1945; accepted Apr. 14, 1948. Unsaturated aldehydes (e.g. acrolein, crotonaldehyde, cinnamic aldehyde) are condensed (by heating) with an alpha-beta-unsaturated dicarboxylic acid or its anhydride (e.g. maleic acid, maleic anhydride, fumaric acid, glutaconic acid, citraconic acid, itaconic acid), or substances which will give rise to these compounds under the conditions of reaction, and reacting the adduct thus obtained with a fatty oil, the fatty acids derived therefrom and/or a partial ester thereof containing at least one free hydroxyl group, and if necessary an alcohol to complete esterification of any free hydroxyl groups. After the addition of driers, solutions of these products give hard films by drying at normal temperatures for a few hours.

SYNTHETIC RESINS AND STOVING ENAMELS. Brit. Pat. 600,662. D. H. Finn, S. R. Finn and R. M. A. Welchman. Applied for Sept. 29, 1944; accepted Apr. 15, 1948. Phenol-formaldehyde liquid resins intended for use as stoving enamels resistant to water and acids are produced by effecting slow controlled condensation under reflux conditions of approximately equimolecular proportions of phenol and aqueous formaldehyde in a plurality of increasing temperature stages, the temperature in the final stage being not less than 70°C. and not being allowed to exceed 85°C., the temperature and time in the latter stage being coordinated so as to achieve the maximum possible uniformity in the rate of reaction (as manifested by the absence of pinholing on stoving) using as catalyst from 0.6 to about 1.9% calculated on the phenol of ammonia or equivalent quantities of triethanolamine, pyridine or trimethylamine, and terminating the reaction when the liquid resin has attained a viscosity of from 800-1500 centistokes at 25°C. Such resins are incorporated with a solvent mixture and pigments (e.g. titanium oxide, green chromium oxide or barium sulfate mixtures with china clay, or carbon black) to give stoving enamels resistant to corrosion and chemical warfare agents.

COMPOSITIONS CONTAINING MODIFIED CASTOR OIL FATTY ACID RADICALS. Brit. Pat. 600,705. D. H. Hewitt and F. Armitage

(assigned to Lewis Berger & Sons, Ltd.). Applied for Mar. 31, 1944; accepted Apr. 16, 1948. A composition having air-drying properties is produced by heating a castor oil fatty acid or polyhydric alcohol ester thereof with an acidic varnish resin (preferably melted first) at a temperature between 500°F. and 630°F. for a period of time sufficient to effect at least partial dehydration of the fatty acid or ester.

SOLVENT STABLE PHTHALOCYANINE PIGMENTS. Brit. Pat. 600,911. R. H. Wiswall, Jr. (assigned to American Cyanamid Co.). Applied for Mar. 28, 1944 (applied for in U. S. Mar. 12, 1943 and Mar. 3, 1944); accepted Apr. 22, 1948. A process for preparing phthalocyanine pigments which will not increase in particle size and thereby lose tinctorial power on contact with the usual organic solvents such as those encountered in coating compositions, involves the transformation of finely divided sulfuric acid-stable halogen-free phthalocyanine pigments into a coarse crystal form with large particle size, grinding these crystals with an equimolar or greater quantity of a grinding aid (e.g. salt, a soluble carbohydrate, calcium carbonate, diatomaceous earth, blanc fix, powdered silica or an inert filler capable of acting as a pigment extender which does not have to be removed) to reduce the average particle size to under two microns and then subjecting the crystals to the action of a crystallizing solvent. Slight growth in crystal size results but the average particle size remains small enough so that the material is stable against further crystal growth in crystallization solvents and the pigment can be incorporated in coatings such as inks, paints and lacquers stored for long periods of time.

IMPROVING THE DRYING PROPERTIES OF OILS. Brit. Pat. 601,313. Emery Industries. Applied for Jan. 30, 1945 (applied for in U. S. Nov. 6, 1942); accepted May 4, 1948. The drying properties of drying and semi-drying oils are improved as to speed of drying, and the water resistance and impermeability of films formed therefrom, by treating the oil at elevated temperatures with an aliphatic dibasic acid (e.g. azelaic, adipic or sebacic acids) which displaces non-drying constituents from the oil and which has a vapor pressure at ordinary temperatures lower than the vapor pressure of the displaced constituents, and then removing the non-drying constituents from the oil by distillation.

ELECTRICAL INSULATING VARNISH FOR WIRES. French Pat. 873,627. Schenectady Varnish Co. Applied for July 7, 1939 (applied for in U. S. July 25, 1938); delivre Mar. 30, 1942. An electrical insulating varnish for wires is made by heating a polyvinyl acetal resin completely or partially hydrolyzed, and an ingredient serving to regulate the viscosity during the initial phases of cooking. The viscosity-controlling agent may be phenol, a cresol, xylenol, diphenyl, chlorinated diphenyl or cashew nut oil.

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RECENT ADVANCES IN PAINT TECHNOLOGY

THE DIFFUSE SPECTRAL REFLECTANCE OF PAINTS IN THE NEAR INFRA-RED. A perforated hemispherical reflector made of half of a Pyrex flask has been employed to collect diffusely reflected light from a surface to be measured on a photo-cell or thermopile placed at a focal point of the hemisphere conjugate to the position of the sample, thus providing adequate amounts of energy on the thermopile to permit spectral-reflectance measurements to longer wavelengths than with usual reflectance spectrophotometers. Relative diffuse spectral-reflectance curves extending to 2.5μ are given for a number of "infra-red reflecting" paints, showing qualitatively the superiority of high index of refraction, large particle size, and low extinction coefficient in producing layers of pigments having high scattering coefficients in the near infra-red.

The use of the hemispherical integrator with a tungsten source and a Wratten 87 filter and with either a thermopile or photo-cell receiver is illustrated by measurements which show that the thermopile-Wratten 87 system, embracing wavelengths 0.76 to 2.6μ, produced reflectance factors which more nearly approximated integrated reflection factors for sunlight between 0.76 and 2.4μ and more truly indicated the effect of variations in physical characteristics of the reflecting material than did photo-cell measurements embracing wave-lengths 0.76 to 1.2μ.

The use of a caesium oxide cathode, infra-red image tube in making rapid inspections of surfaces in the region of wave-length shorter than 1.2μ is described. J. A. Sanderson. J. Optical Soc. Am. **37**, 771-777 (1947), No. 10, October.

THE TOTAL EMISSIVITY OF VARIOUS MATERIALS AT 100-500°C. Total emissivities have been obtained for various metal, carbon, paint-coated, and glass samples. The carbon and glass samples were measured at about 500, 320, and 100°C; the others only at 100°C. The equipment consisted of a thermopile, three diaphragms, and three shutters, all at 0°C, and suitable heaters. For calibration, a special blackbody at 100°C was used. Its principal feature was a polished conical brass mirror, also at 100°C. for reflecting blackbody radiation to the thermopile.

The emissivity data for glass were corrected for radiation transmitted through the sample from the blackened heater surface, and for the temperature gradient in the sample. The resulting emissivity values ranged from 0.82 to 0.91 for two glass samples and from 0.67 to 0.775 for fused quartz. For pressed carbon plates, the range was 0.71 to 0.77; for radiator paints, 0.29 to 0.84; for well polished metals, 0.05 to 0.135. B. T. Barnes, W. E. Forsythe, and E. Q. Adams. J. Optical Soc. Am. **37**, 804-809 (1947), No. 10, Oct.

OPTICAL SCATTERING BY DIELECTRIC POWDERS OF UNIFORM PARTICLE SIZE. The spectral-transmission curve of a film of dielectric powder having uniform particle size shows a very pronounced minimum corresponding to the Mie scattering maximum. The wavelength of this Mie minimum changes as the refractive index of the medium surrounding the particles is changed. If a film of dielectric powder is prepared and the wave-lengths of the Mie minima are determined when liquids of different refractive index are flowed around the particles then, if the wavelength values are plotted against the refractive indices of the surrounding media, the points fall on a straight line that intersects the axis at the refractive index of the powder, thereby providing a method for measuring the refractive index of powders above the range of immersion liquids. A method, using the data for the Mie minima, is described for determining the optimum particle size for white paint pigments. This method is illustrated with data on zinc sulfide and titanium dioxide. J. R. DeVore & A. H. Pfund. J. Optical Soc. Am. **37**, 826-832 (1947), No. 10, Oct.

SUPPRESSION OF RADIATIONS AT HIGH TEMPERATURES BY MEANS OF CERAMIC COATINGS. A method was developed for measuring the emissivities of ceramic coatings and ceramic-coating materials with respect to oxidized stainless steel. The emissivities in the visible-red and near-infrared spectral regions were studied over a temperature range of 800° to 1600°F. The numerous materials investigated were found to cover an emissivity range from more than 100% to less than 10%. Lepidolite was the highest emitter, Uverite the lowest. Transmission of radiant energy decreased with coat thickness according to established laws. The bonding glasses could be greatly influenced by transmission of radiant energy through coat-composition. Every material has a characteristic tendency to emit radiations at a given temperature. High-temperature ceramic paints were found to be effective radiation suppressors and thermal insulators. D. G. Bennett, J. Am. Ceram. Soc. **30**, 297-305 (1947), No. 10, Oct. 1.

PETROLEUM PRODUCTS IN THE PRINTING INK AND ALLIED INDUSTRIES. After a brief survey of the mechanisms by which fluid inks are converted to rubproof films on paper, and the types of printing currently used, the authors take up the uses of various petroleum products in the printing ink and similar fields. These products include volatile petroleum products, mineral oils, carbon-black and lamp-black, petroleum waxes, petroleum jelly, bitumens, petroleum aromatic extracts and resins, naphthenates, and materials such as soap greases, wetting agents and miscellaneous products. A. C. Healy and L. Ivanovszky. J. Inst. of Petroleum **33**, 531-551 (1947).

SPECIFICATIONS AND TESTING OF PAINTS. Four papers given at the recent conference of the Oil and Colour Chemists' Association dealing with the testing and specifications of paints are discussed. (1) The Performance Testing of Paints, with Particular Reference to Tests Which Have a Bearing on Ultimate Outdoor Durability. Tests for hardness, adhesion, flexibility, water-vapor permeability, accelerated weathering, suggested weathering cycles, testing of priming paints and prevention of creep corrosion are taken up. (2) Testing Decorators' Finishes. Performance tests, tests relating to the condition of the film, practical evaluation and method of compiling specifications. (3) Tropical Paints. Description of tropical conditions, durability of paints in the tropics, other defects of paints in the tropics, drying difficulties, mold growths, and possible methods of test are discussed. (4) Paints in Railway Service. Factors affecting their choice, surface preparation, methods of application, painting schedule employed, requirements of interior finishes, treatment of interior body shell, painting and cleaning of structures and flame cleaning of bridges are covered. Paint Manuf. **17**, 219-237 (1947).

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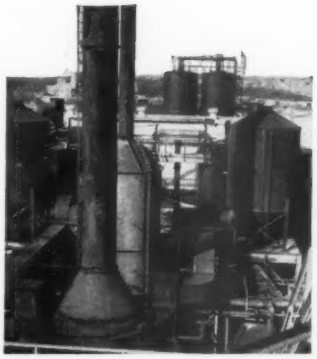

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CHEMICAL INSTITUTE OF CANADA, THIRD ANNUAL GENERAL MEETING (Banff, Alberta, June 9, 1947). Abstracts of some of the papers follow: "The Dispersion of Carbon Black in Petroleum Oils, Waxes and Oil-Wax Mixtures" by E. S. Gale and B. J. Staneslow. Studies were made of dispersions of carbon blacks in petroleum oils, waves and oil-wax mixtures which are often ground in ball mills and applied as surface coatings by high speed machines or used on printing presses. In these operations it is necessary that the mixture have a high "flow value," a property which can be measured industrially by determining the recovery from an experimental ball mill operated under standard conditions. The paper gives an account of an investigation of the factors contributing to "flow value" and describes a microscopic technique for studying and evaluating flow-producing agents. "Protective Coatings for Corrosion Prevention" by R. M. Burns. The processes of corrosion of metals are described and the role of protective coatings in corrosion control outlined. Recent developments in metallic and organic coatings are discussed, methods of quality control mentioned, and future trends in corrosion prevention predicted. "The Application of Statistical Methods to the Testing of Finishes" by D. B. W. Reid and T. H. G. Michael. The mathematical methods used in statistical analysis are described in an elementary manner. Parallels are drawn between common statistical application, and the situations existing in protective coating testing. Examples of the methods as applied to certain paint testing methods are given. Emphasis is placed on the use of multiple panels for exposure tests. "Some Trends in Protective Coatings" by D. R. Wiggam. Figures on total U. S. sales, current investment and volume trends over a period of years for oils, paints, resin coatings and lacquers, together with the trends in consumption of essential raw materials are given. Developments which have taken place in the lacquer industry are discussed such as high solids nitrocellulose lacquers for metal and wood, hot spray methods of application, brushing lacquers, metallized lacquers and heat sealing lacquers for paper for the packaging industry. Molten plastic coatings for metal based on ethyl cellulose and cellulose acetate butyrate are mentioned, as well as specialty lacquer applications for ethyl cellulose, cellulose acetate and cellulose acetate butyrate. Water-soluble coatings from carboxy-methylcellulose and methylcellulose for papers to render them greaseproof are considered. The function of chlorinated rubber in the manufacture of fireproof and chemically resistant coatings for wood, metal and concrete is referred to; also a new plasticizing oil and resin for use in paints and chlorinated paraffin. Mention of some of the more recent raw materials for protective coatings such as methacrylates, polystyrene-oil and polystyrene-alkyd combinations and of the silicones is made.

SOCIETY OF PLASTICS ENGINEERS ANNUAL TECHNICAL MEETING REPORTS. Abstracts of the paper presented before the annual meeting of the S. P. E. held in Chicago, Jan. 27-31 included the following: Coatings by E. H. Bucy (survey of alkyd resins, nitrocellulose, acrylic resins, modified phenolics, vinyl chloride and vinyl acetate-chloride coatings); Plastic Dipping by L. Becker (review of practical applications of dipping method for producing coatings or films).

ALLYLSUCROSE—A VARNISH RESIN. Preliminary results of an investigation of allylsucrose indicate that it is a good varnish resin. The product is made by reaction of allylchloride and sucrose in the presence of an alkali. Varnish formulations employ regular paint driers—cobalt catalysts and the like—rather than peroxide catalysts, which appear to have no effect. A pilot plant is planned to turn out experimental batches. Anon. Chemical Industries **60**, 767 (1947).

ACENAPHTHYLENE RESINS. Acenaphthene, found in coal tar, may be hydrogenated to acenaphthylene which may be polymerized in bulk at 98°C. for 72 hours to give a resin having a molecular weight of 90,000, or by heating with benzoyl peroxide to a high molecular weight polymer. It can also be polymerized in solution and at low temperatures with ionic type catalysts. It will also copolymerize with other monomers such as styrene, methyl methacrylate and vinylcarbazole. The polymers are useful as film-forming materials, as coating agents, as bonding agents, as impregnants, as molding materials, and particularly as dielectric materials. Anon. Chemical Industries **60**, 814 (1947).

CABOLT LITERATURE

A book written by Roland S. Young, Ph.D., chief research chemist, Rhokana Corporation, Nkana, Northern Rhodesia, has just been published entitled "Cobalt," about which the author says in part.

"Information on the chemistry and metallurgy of cobalt is widely scattered in technical literature. It appeared desirable to assemble and review critically existing data on this subject, and to present certain unpublished features and developments which have come within the author's experience with this metal and its compounds.

"This monograph is written for two classes of readers: (1) The chemist, or other scientific worker, who has occasion to work with cobalt and wants accurate, up-to-date, and complete information; (2) the chemist or metallurgist who wishes to browse through this field in the hope of adding to his general knowledge or picking up ideas which may be applicable to his own sphere of work."

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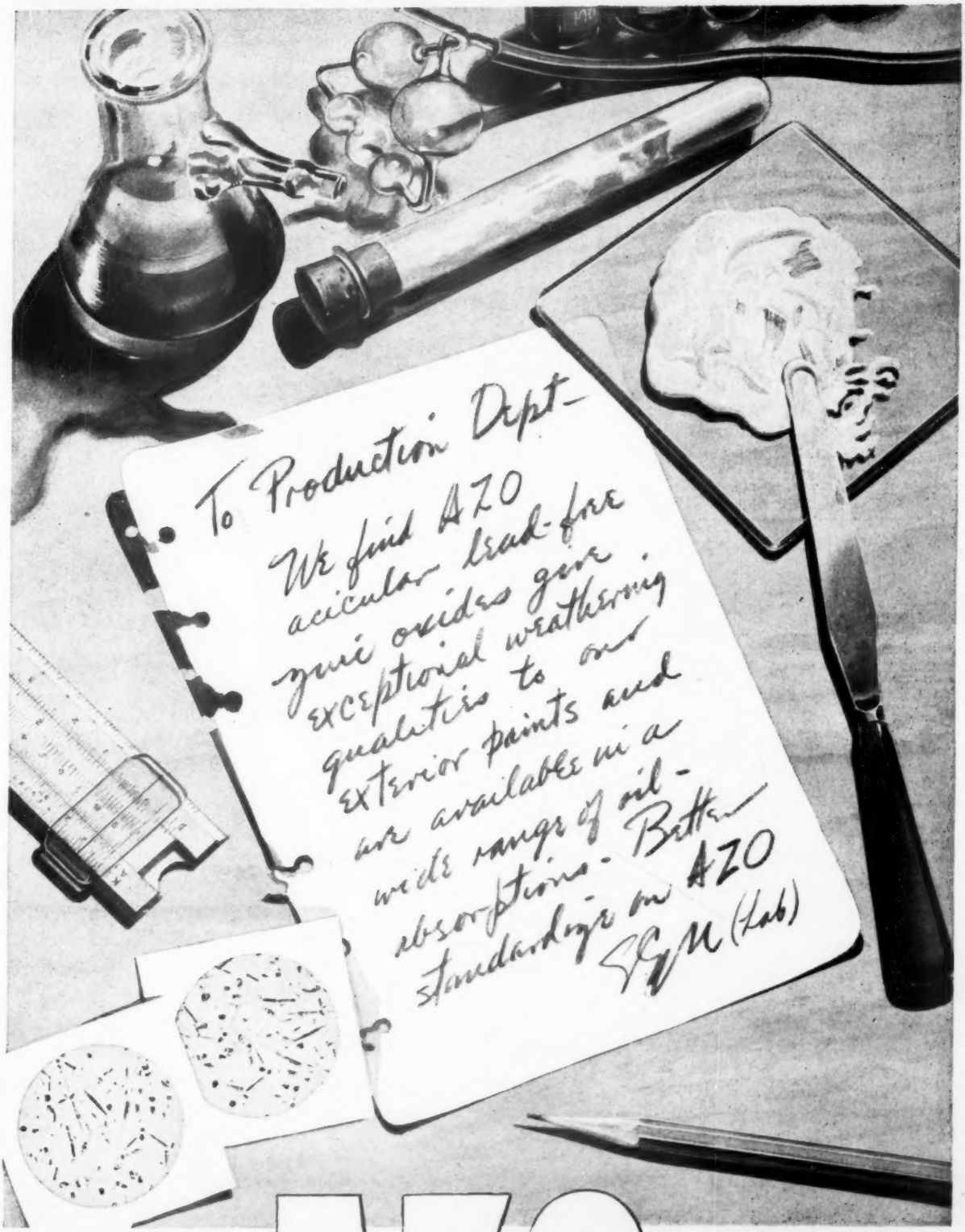

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